High Resolution Photoionization Measurements of Mg^{+} and Al^{+} Ions

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INTRODUCTION

The measurements presented here were undertaken to provide high resolution data on the photoionization cross sections of the singly charged ions of Mg and Al. The initial measurements were made at the ASTRID storage ring at the University of Aarhus, where absolute cross sections were obtained, but the photon energy resolution was insufficient to identify all the spectral structure. This was particularly evident in regionswhere the 2p $\rightarrow$ nd and ns resonances overlapped; configuration interaction was strong in these regions and it was difficult to make firm assignments. Beamline 10.0.1 at the ALS was able to provide resolution down to $\sim$5 meV in the photon energy region of interest, thereby revealing the underlying structure in the features observed previously [1, 2]. In this ALS experiment there was no requirement to make absolute measurements, since these had already been made on ASTRID. The present data could therefore easily be normalised to the earlier data to obtain oscillator strengths for the newly resolved structure.

EXPERIMENT

The measurements were made using the merged beam method, originally used for electron scattering cross sections [3] and later adapted for photoionization cross section measurements at the Daresbury Synchrotron Radiation Source [4]. At the ALS an ECR source was used to generate the ions of interest; it contained a metal vapour oven so that metallic ions could be produced. The ions were then magnetically selected and deflected electrostatically to merge with the path of the photon beam from a spherical grating monochromator over a length of $\sim$30 cm. The parent beam intensity was measured in a Faraday cup, and the ionised products were incident upon a stainless steel plate. The secondary electrons thus generated were detected by a microspherical plate; further details of the experimental equipment have been given by Covington *et al* [5].

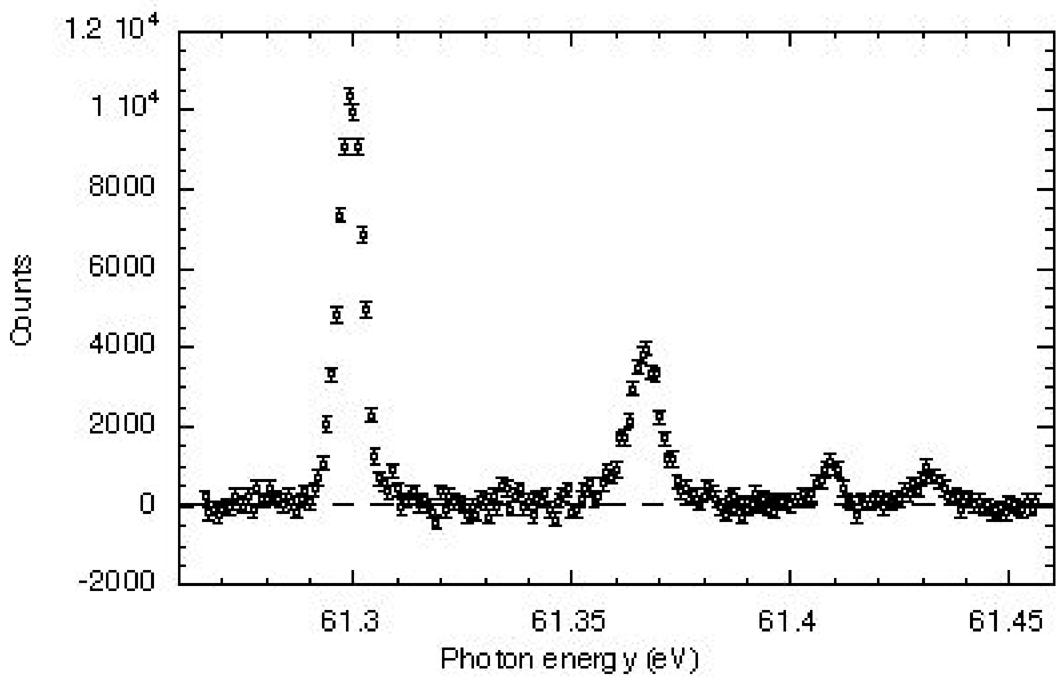

Figure 1: The photoionization spectrum of Mg^+.

RESULTS

For Mg^+ measurements were made over the photon energy range 61-68 eV, and a sample of these is shown in Fig. 1;these are preliminary results which have not been normalised and they are therefore relative. Four lines are evident, where previously one was observed. The lines at 61.30 and 61.37 are to be associated with transitions to the $2p^5 3s3d(^3D)\ ^2P$ levels of Mg^+, and the remaining two lines are probably due to transitions to the $2p^5 3s4s(^1S)$ levels. In Fig. 2 the corresponding region for Al^+ is shown. Rydberg series converging to the $2p^5 3s^2$ level of Al^{2+} at $\sim$92 eV are clearly evident.

Although a straightforward quantum defect analysis has been applied to the data above, the results are far from conclusive because of the large degree of configuration interaction taking place; the assumption of LS coupling may also be invalid. Even the above assignments must remain tentative until theoretical calculations are available; such calculations, using both the Multiconfigurational Hartree-Fock and R-matrix methods, are currently in progress.

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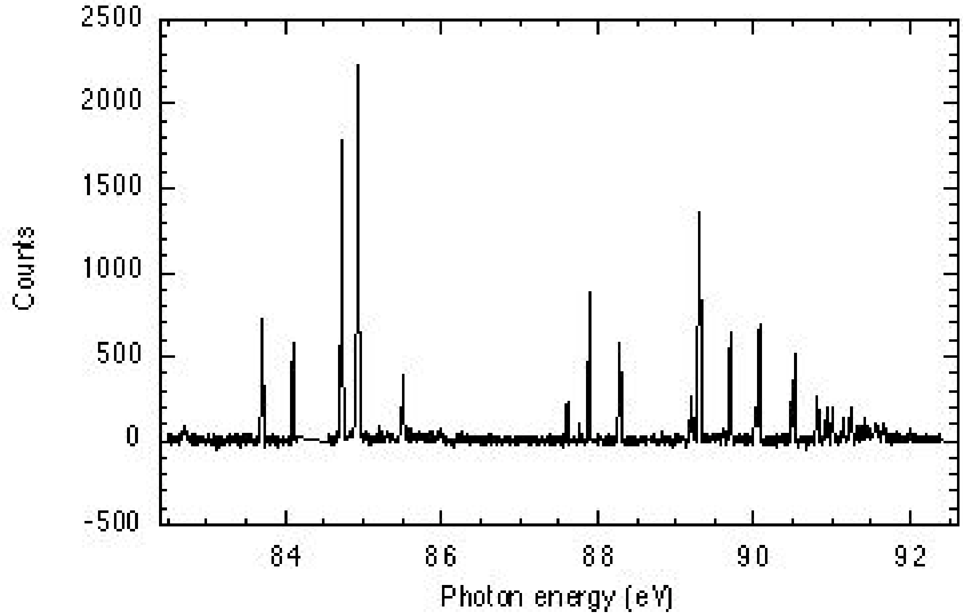

Figure 2: The photoionization spectrum of Al^+.

References

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